Space Weather Technical Forecast

Issued on Saturday, 08 October 2022 at 01:27 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Ongoing chance of M-flares, primarily from AR3112 and AR3116

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate with one long period M1.0 flare observed from AR3116 Eai/Beta in the north-centre disc, alongside a couple of C-flares. This is a relatively small and simple bipolar region, although spreading of its leader and trailer, which are both displaced north-south from each other, likely induced some instability. C-flares have also been observed from AR3112 Fki/Beta-Gamma-Delta, also in the north centre disc. This is the largest region on the disc, although has now been split into two regions, with a small leader region now designated AR3120 Axx/alpha. This means that the former intermediate spot is now the complex leader of AR3112, but with one, perhaps two, delta spots persisting within it. Intermediate spots continue to proliferate around the trailer region, although activity from this active region remains minimal. Overall there are seven numbered sunspot regions, however the other regions are generally smaller and simpler although AR3119 Dri/Beta in the northwest continues to show slow growth

There are number of filaments visible on H-alpha imagery of the Earth-facing disc, and one of these was observed erupting at around 0730 UTC. The resultant CME has been assessed as likely missing, passing just ahead and north of Earth but with a very slow chance of peripheral influences late on day 4 (11th). No other Earth-directed CMEs were observed.

Solar Wind / Geomagnetic Activity: The solar wind remained indicative of Earth being within the fast wind, perhaps of CH28 of CH30, but potentially with peripheral CME influences. DSCOVR observed wind speeds at L1 indicated an erratic decline from elevated levels of 520km/s to be slightly elevated at around 450 km/s, before an increase at around 07/1000 UTC, rising back to vary between 520-580 km/s for the rest of the period. This may be due to the glancing influence of the anticipated CME, however, this structure is less apparent on ACE leading to significant uncertainty for this to have occurred. DSCOVR density also increased at this time from below average to around average. Very little notable change was observed in the total IMF, Bt, which remained weak at between 6 and 8nT throughout. The north-south component remained variable between +6nT and -7nT, until 07/1330 UTC, when it became predominately positive. The phi angle persisted at a mainly positive direction (away from the Sun). Geomagnetic activity eased from initially Active to be Quiet to Unsettled from 07/0900 UTC (Kp 0-4)

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16, has been at Background levels. High energy electron flux (greater than 2 MeV) has been at Moderate to High levels, peaking at 2900 pfu at 07/1525 UTC. The associated 24 hour fluence rose to be above the Active threshold since 07/1500 UTC. The 08/0000 UTC observation was 1.14e8 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar Activity is forecast to be Low to Moderate, with the possibility of further M-

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flares from AR3116. Whilst AR3112 has remained relatively stable, this still has the potential for M-class flares, with a slight chance of X-class flares.

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs in the forecast, however a CME that misses the Earth on the 11th may give some peripheral influences. This is due to the filament eruption observed 07/0730 UTC. Otherwise, current elevated solar winds are expected to perhaps ease day 1 (8th) for a time, before a further enhancement from any fast wind arrival of CH29 either later day 1 or day 2 (8th or 9th). This is low confidence, due to its small size and being new on this rotation. Any enhancement is then likely to ease by day 4 (11th). Quiet to Unsettled geomagnetic activity is expected at first, with a chance of rising to Active, and a slight chance of G1/Minor Storms late day 1 and day 2 (7th and 8th) from any fast wind arrival. Easing back to Quiet to Unsettled day 3 and 4, (9th and 10th) with a slight chance of Active.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) is expected to be near Background for much of the period, but with a slight chance of rising in response to any large flares from AR3112 and perhaps AR3116. These may approach the S1 level, with a slight chance of rising above. Electron flux (greater than 2 MeV) is likely to persist at Moderate to High levels, albeit with a slight suppression possible from any fast wind enhancement that occurs Earths solar wind environment late on day 1 or early day 2(8th or 9th). The associated electron fluence is forecast to persist at Active levels, only gradually declining later in the period.

Figure 0: H-alpha imagery showing the large number of filaments on the disc

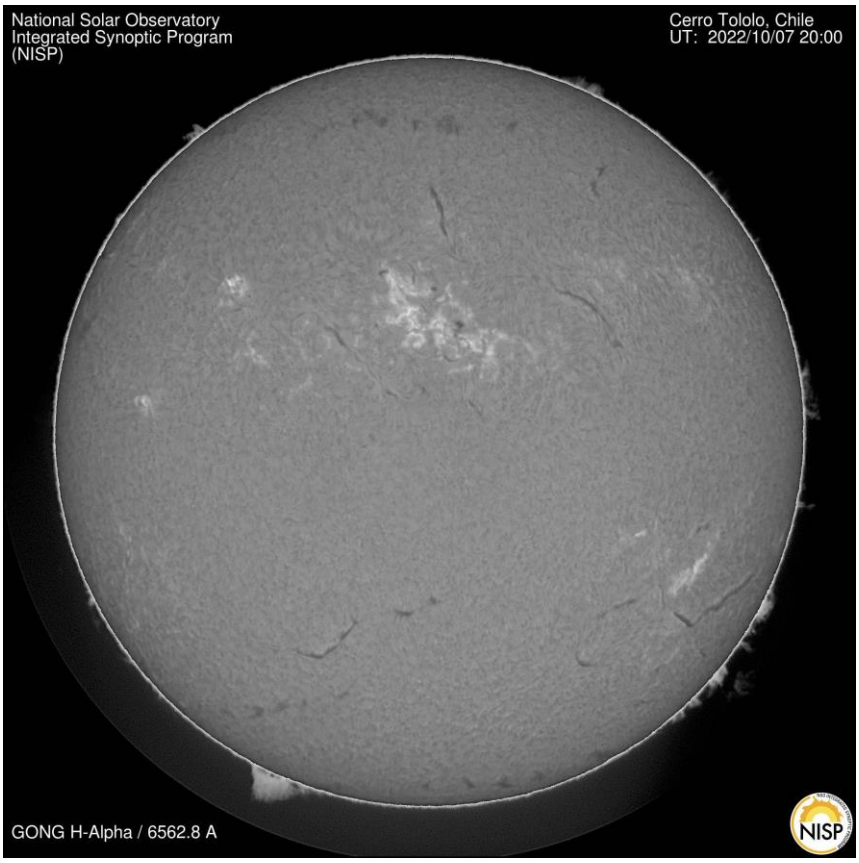

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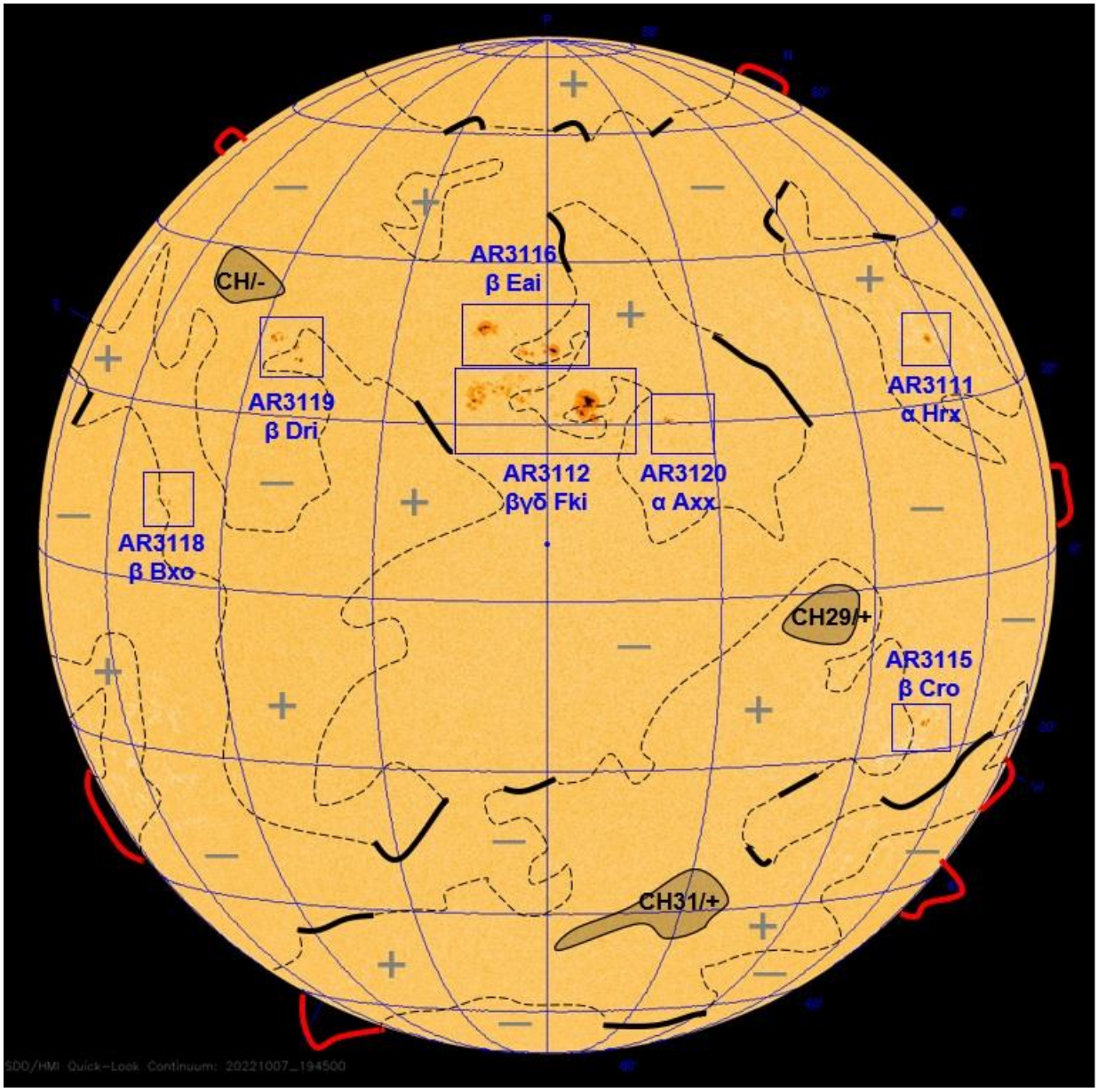
Figure 1. Solar Analysis Valid 07/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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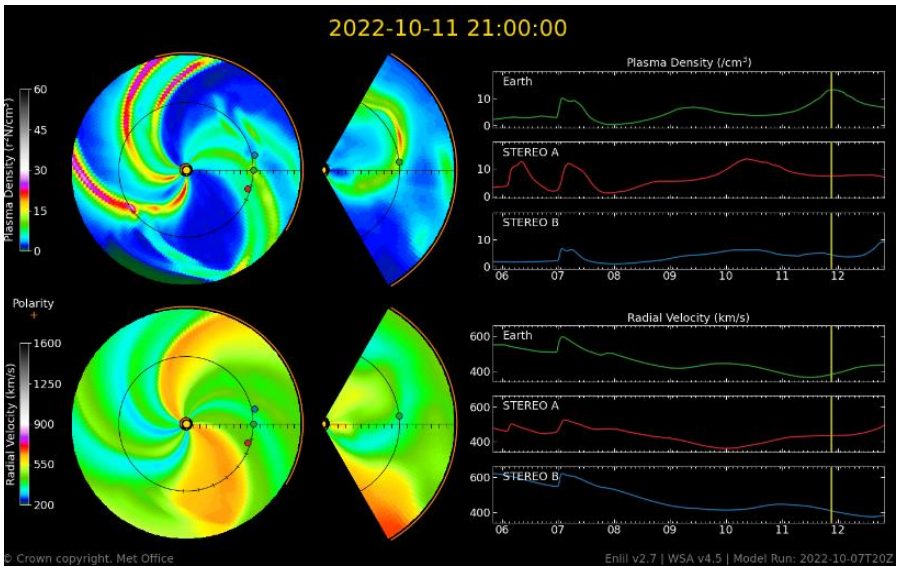
Geomagnetic Storms:

There are now no Earth-directed CMEs in the forecast. However a filament eruption in the northeast disc was observed at 07/0730 UTC, with the subsequent ejecta from the CME expected to miss passing ahead and north of Earth. However there is the potential for a very slight glancing interaction late on day 4 (11th) as this passes close by.
Solar winds at Earth have continued at elevated levels, potentially due ongoing fast winds from previous coronal holes (CH28 and CH30), coupled with the peripheral influence of passing CMEs, however the later cannot be confidently identified amongst the solar wind due to their very weak impacts.
Solar winds are now expected to ease day 1 (8th), before a further small enhancement is possible from the arrival of any fast wind from CH29 either later in the day or during day 2 (9th). This is a small feature, with only a very slight increase visible on enlil model runs, and was also not present on the previous rotation for persistence to be of useful guidance. Consequently any enhancement to solar winds is very low confidence. Winds will then likely decline further, falling towards background levels by day 4 (11th).
Quiet to Unsettled geomagnetic activity is expected at first, with a chance of rising to Active, and a slight chance of G1/Minor Storms late day 1 and day 2 (7th and 8th) from any fast wind arrival. Easing back to Quiet to Unsettled day 3 and 4, (9th and 10th) with a slight chance of Active.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	20	1	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: Enlil, showing potential for weak peripheral influences from CME



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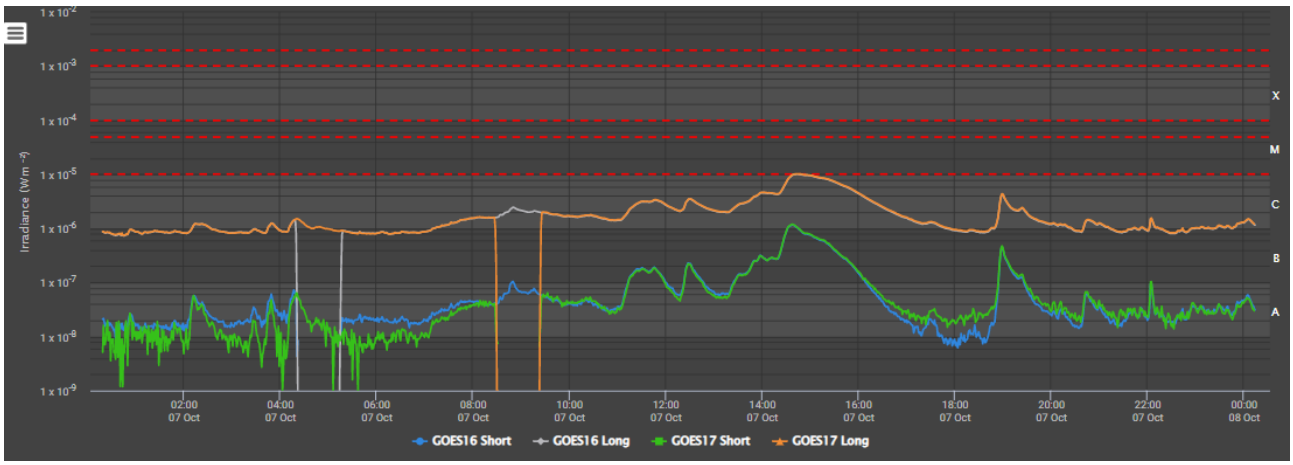
Radio Blackouts - X-Ray Flares:

Solar Activity has been Moderate with the recent M1.0 flare observed from AR3116 Eai/Beta in the north centre disc. This is one of seven numbered active regions on the Earth-facing disc, lying to the north of the larger, more complex but also more stable AR3112 Fki/Beta-Gamma-Delta. Overall activity is forecast to persist at Moderate to Low levels but with a slight chance of isolated X-flares.

These two regions comprise the majority of the flare risk on the disc. Despite recent splitting into two smaller regions, AR3112 still comprised of the main bulk of the sunspot, with at least one, and potentially two, delta spots in what is now its main complex leader region. However this region continues to show a gradual reduction in areal extent and little sign of significant flaring. AR3116 remains a relatively simple bipolar region, however the trailer and leader are displaced north-south slightly, giving potential from some shear and induced instability, with further M-flares possible. The other region of note is AR3119, in the northeast, which whilst currently smaller and simpler, has exhibited some slow growth in the last 24 hours. However, significant flares remain unlikely from this spot without further growth. The other regions are all smaller and simpler.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	50	40	40	40
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 3: GOES-16/17 X-ray Flux



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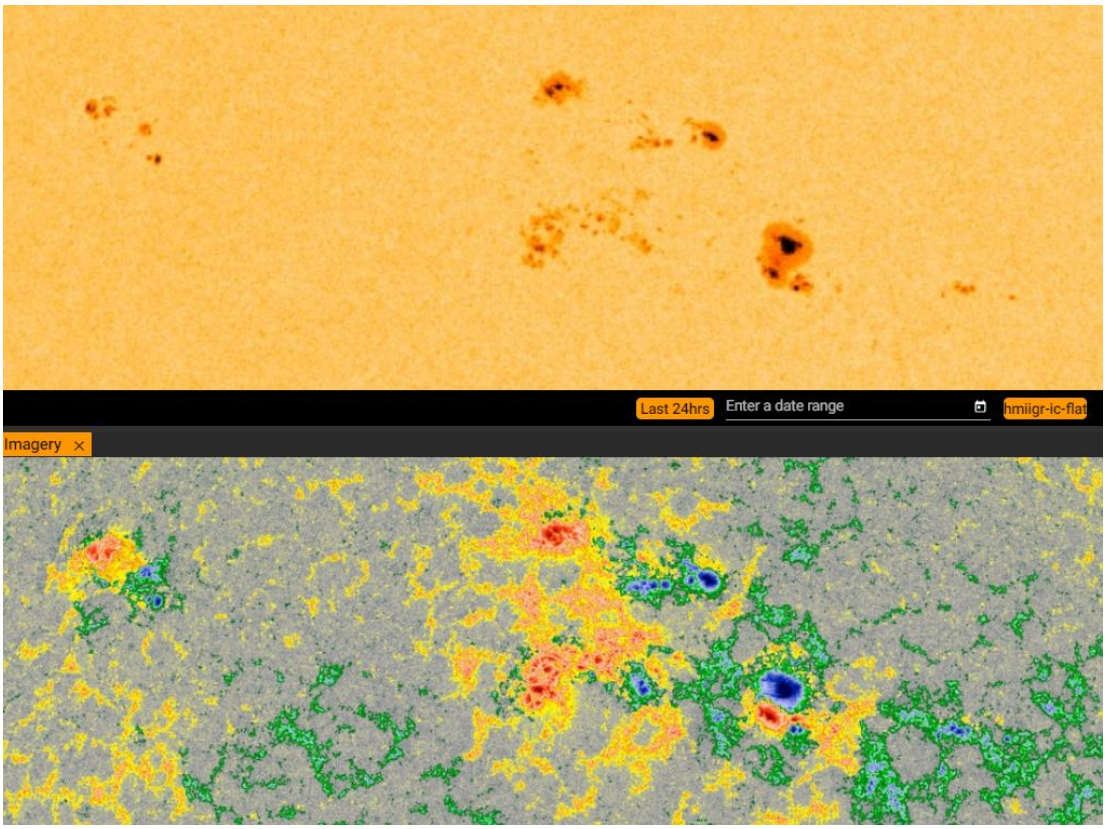
Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10MeV) as observed by GOES-16 is currently at Background levels. AR3112 in the centre disc is moving into the western hemisphere. While flare activity from this region has remained relatively subdued, there remains the potential for large M-flares, and the slight chance of X-ray flares. AR3116 to the north of this region, whilst smaller and much simpler has recently produced an M1.0 flare and also has the potential for further flares. Combined these two regions give a chance of proton levels increasing with any significant flares that occur, perhaps approaching the S1-level with a slight chance of exceeding.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	10	10	10	10
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: SDO intensitygram and magnetogram of northern hemisphere sunspots (From left to right, AR3119, AR3116 (top), AR3112 (bottom) and AR3120)



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High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2 MeV) electron flux as observed by GOES-16 has persisted at Moderate to High levels in the last 24 hours, and little change is anticipated at first. A potential suppression is possible later day 1 and during day 2 from any fast wind arrival of CH29, however this is both low confidence and expected to be relatively weak should it occur. Otherwise, only a gradual decline in peak fluxes is expected, with further periods of High likely each day.

The associated 24 hour electron fluence is forecast to remain Active day 1 (8th) and into day 2 (9th). Confidence then falls due to any suppression of flux that occurs from CH29 fast wind arrival, however Active levels are expected to persist. REFM is currently giving poor guidance after T+24, and should be disregarded beyond this period.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	100	90	70	60
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: GOES 16 >2MeV Electron Flux and associated fluence with REFM

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